U.S. Department
of Transportation

Pipeline and
Hazardous Materials
Safety Administration

East Building, PHH-23
1200 New Jersey Avenue Southeast
Washington, D.C. 20590

COMPETENT AUTHORITY CERTIFICATION FOR A TYPE B(U)F FISSILE RADIOACTIVE MATERIALS PACKAGE DESIGN CERTIFICATE USA/9358/B(U)F-96, REVISION 1

This certifies that the radioactive material package design described has been certified by the Competent Authority of the United States as meeting the regulatory requirements for a Type B(U)F packaging for fissile radioactive material as prescribed in the regulations of the International Atomic Energy Agency[1] and the United States of America[2].

1. Package Identification - TN-LC.

2. Package Description and Authorized Radioactive Contents - as described in U.S. Nuclear Regulatory Commission Certificate of Compliance No. 9358, Revision 2 (attached).

3. Criticality - The minimum criticality safety index is as assigned in the NRC Certificate of Compliance (attached). The maximum number of packages per conveyance is determined in accordance with Table X of the IAEA regulations cited in this certificate.

4. General Conditions -

   a. Each user of this certificate must have in his possession a copy of this certificate and all documents necessary to properly prepare the package for transportation. The user shall prepare the package for shipment in accordance with the documentation and applicable regulations.

   b. Each user of this certificate, other than the original petitioner, shall register his identity in writing to the Office of Hazardous Materials Technology, (PHH-23), Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation, Washington D.C. 20590-0001.

   c. This certificate does not relieve any consignor or carrier from compliance with any requirement of the Government of any country through or into which the package is to be transported.

---

[1] "Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised), No. TS-R-1 (ST-1, Revised)," published by the International Atomic Energy Agency(IAEA), Vienna, Austria.

[2] Title 49, Code of Federal Regulations, Parts 100-199, United States of America.

CERTIFICATE USA/9358/B(U)F-96, REVISION 1

d. Records of Quality Assurance activities required by Paragraph 310 of the IAEA regulations[1] shall be maintained and made available to the authorized officials for at least three years after the last shipment authorized by this certificate. Consignors in the United States exporting shipments under this certificate shall satisfy the applicable requirements of Subpart H of 10 CFR 71.

5. Special Condition - Transport by air of fissile material is not authorized.

6. Marking and Labeling - The package shall bear the marking USA/9358/B(U)F-96 in addition to other required markings and labeling.

7. Expiration Date - This certificate expires on December 31, 2017.

This certificate is issued in accordance with paragraph 814 of the IAEA Regulations and Section 173.471 and 173.472 of Title 49 of the Code of Federal Regulations, in response to the June 11, 2014 petition by Areva - TN Inc, Columbia, MD, and in consideration of other information on file in this Office.

Certified By:

Jul 02 2014
(DATE)

for Dr. Magdy El-Sibaie
Associate Administrator for Hazardous Materials Safety

Revision 1 - Issued to endorse U.S. Nuclear Regulatory Commission Certificate of Compliance No. 9358, Revision 2.

2. PREAMBLE

a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO *(Name and Address)*

AREVA Inc.
7135 Minstrel Way, Suite 300
Columbia, MD 21405

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

TN-LC Transportation Package Safety Analysis Report, Revision No. 6, dated November 2012, as supplemented.

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: TN-LC

(2) Description

The packaging, designed for transport of irradiated test, research, and commercial reactor fuel in either a closed transport vehicle or an ISO container, consists of a payload basket, a shielded body, a shielded closure lid and top and bottom impact limiters. The packaging body is a right circular cylinder, approximately 197.5 inches long and 30 inches in diameter, composed of top and bottom end flange forgings connected by inner and outer shells. Lead shielding, made of ASTM B29 copper lead, is placed between the two cylindrical shells, in the bottom end assembly, and in the lid. Neutron shielding, composed of a borated resin compound inserted into twenty aluminum shield boxes, is set between the outer shell and a 0.25 inch-thick Type 304 stainless steel outer sheet. Two removable trunnions are bolted to the packaging body using eight 1-8UNC bolts for each trunnion. Two pocket trunnions in the bottom flange, used for rotating the package, may also be used for horizontal package lifting. Impact limiters, with an approximate outside diameter of 66 inches and height of 22.75 inches, consisting of balsa and redwood blocks encased in stainless steel shells, are attached to each end of the packaging during shipment, each with eight 1-8UNC bolts.

Four basket designs are provided for transport of Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), Mixed Oxide Fuel (MOX), Evolutionary Pressurized Reactor (EPR), National Research Universal Reactor (NRU), National Research Experimental

5.(a)(2) Description (Continued)

Reactor (NRX), Material Test Reactor (MTR), and Training, Research, and Isotope General Atomics Reactor (TRIGA) fuel assemblies, fuel elements or fuel rods.

The packaging may be loaded or unloaded either in a pool or a hot cell environment. The spent fuel payload is shipped dry in a helium atmosphere.

Nominal weights and dimensions are as follows:

- Overall length with impact limiters:	230 inches
- Overall length without impact limiters:	197.50 inches
- Cavity length (minimum):	182.50 inches
- Cavity inner diameter:	18 inches
- Lid thickness:	7.50 inches
- Weight of contents:	7,100 lbs
- Weight of lid:	1,000 lbs
- Weight of impact limiters:	3,000 lbs
- Total loaded weight of the package:	51,000 lbs

(3) Drawings

The packaging is constructed and assembled in accordance with the following drawings:

65200-71-01 Revision 6	TN-LC Cask Assembly (11 sheets)
65200-71-02 Revision 0	TN-LC Transport Cask Regulatory Plate (1 sheet)
65200-71-20 Revision 4	TN-LC Impact Limiter Assembly (3 sheets)
65200-71-21 Revision 1	TN-LC Transport Packaging Transport Configuration (1 sheet)
65200-71-40 Revision 4	TN-LC-NRUX Basket Basket Assembly (5 sheets)

65200-71-50 Revision 4	TN-LC-NRUX Basket Basket Tube Assembly (5 sheets)
65200-71-60 Revision 4	TN-LC-MTR Basket General Assembly (4 sheets)
65200-71-70 Revision 4	TN-LC-MTR Basket Fuel Bucket (2 sheets)
65200-71-80 Revision 4	TN-LC-TRIGA Basket (5 sheets)
65200-71-90 Revision 3	TN-LC-1FA Basket (5 sheets)
65200-71-96 Revision 4	TN-LC-1FA BWR Sleeve and Hold-Down Ring (2 sheets)
65200-71-102 Revision 4	TN-LC-1FA 25 Pin Can Basket (5 sheets)

5.(b) Contents

(1) Type and Form of Material

(i) Intact or damaged NRU and NRX Mk I fuel assemblies which meet the specifications listed in Table 1 below, respectively, are authorized for transportation in the TN-LC-NRUX basket.

Intact fuel assemblies are fuel assemblies containing fuel rods with no known or suspected cladding defects greater than hairline cracks or pinhole leaks.

Damaged fuel assemblies, with cladding damage in excess of pin hole leaks or hairline cracks, are authorized only if the total surface area of the damaged cladding does not exceed 5% of the total surface area of each rod.

5.(b)(1) Type and Form of Materials (continued)

Table 1

NRU and NRX Mk I Fuel Specifications for Transport in the TN-LC-NRUX Basket

Parameter	NRU	NRX Mk I
Physical and Material Description		
Number of Assemblies	≤ 26	≤ 26
Number of rods/assembly	≤ 12	7
Assembly length (inch) (1)	≤ 116	≤ 116
Nominal Assembly mass (g)	4660	5780
Fuel form	U-Al	U-Al
^{235}U per rod (g)	≤ 45.4	≤ 75.2
Enrichment (wt.% ^{235}U)	≤ 93	≤ 93
Cladding and Spacer Material	Al	Al
Thermal and Radiological Parameters		
Cooling Time (years) (2)	≥ 10	≥ 10
Depletion (wt.% ^{235}U) (3)	≤ 80	≤ 80
Decay Heat per Assembly (watts) (4)	≤ 15	≤ 15

Notes:
1. Maximum length of the fuel assembly (unirradiated) for shipment.
2. The cooling time of the fuel assembly rounded down to 0.5 years.
3. The depletion (or burnup) of the fuel assembly rounded up to 0.5%.
4. The decay heat of the fuel assembly is less than 15 watts at the maximum burnup and minimum cooling time.

(ii) Intact or damaged MTR fuel elements that are enveloped or bounded by the fuel element design characteristics listed in Table 2 below, with an average burnup and minimum cooling time as specified in Table 3 below, and a maximum decay heat of 25 watts per element, are authorized for transportation in the TN-LC-MTR basket.

Intact fuel elements are fuel elements containing fuel plates with no known or suspected cladding defects greater than hairline cracks or pinhole leaks.

Damaged fuel elements, with cladding damage in excess of pin hole leaks or hairline cracks, are authorized only if the total surface area of the damaged cladding does not exceed 5% of the total surface area of each element.

The MTR fuel assemblies shall meet all the requirements in Table 3.

5.(b)(1) Type and Form of Materials (continued)

Table 2

MTR Fuel Element Design Characteristics

Fuel Element Class	M-01	M-02	M-03	M-04	M-05	M-06	M-07	M-08[1]
Number of Fuel Plates [2]	≤23	≤21	≤19	≤17	≤10	≤18	≤17	≤23
^{235}U mass per Plate (g)	≤16	≤16.5	≤17.5	≤19	≤22	≤20.5	≤11.5	≤22
Active Fuel Width (cm)	≤6.7	≤6.7	≤6.7	≤6.7	≤6.7	≤5.9	≤6.7	≤6.7
Active Fuel Length (cm)	≥ 56	≥ 56	≥ 56	≥ 56	≥ 56	≥ 56	≥ 27.5	≥ 56
Enrichment (wt.% ^{235}U)	≤ 94	≤ 94	≤ 94	≤ 94	≤ 94	≤ 94	≤ 94	≤ 94
Fuel Element Depth (cm)	≥7.5	≥7.5	≥7.5	≥7.5	≥7.5	≥7.5	≥7.5	≥7.5

Notes:
1. The M-08 Element class requires that the central stack of fuel elements remain empty. Also, the total ^{235}U mass is limited by the maximum value in Table 3.
2. The plate thickness is greater than 0.12 cm and the clad thickness is greater than 0.02 cm.

Table 3

MTR Fuel Element Qualification

Enrichment Type	Burnup (MWd/MTU)	Cooling Time (days)
Type A ^{235}U Enrichment ≥ 90% ^{235}U Mass ≤ 380 g	66,000	740
	165,000	1120
	330,000	1440
	495,000	1680
	660,000	1950
Type B ^{235}U Enrichment ≥ 90% 380 g < ^{235}U Mass ≤ 460 g	57,750	770
	144,375	1150
	288,750	1470
	433,125	1710
	577,500	1950
Type C 40% ≤ ^{235}U Enrichment < 90% ^{235}U Mass ≤ 380 g	29,330	740
	73,325	1120
	146,650	1440
	219,975	1690
	293,300	1940
Type D 19% ≤ ^{235}U Enrichment < 40% ^{235}U Mass ≤ 470 g	13,930	830
	34,825	1220
	69,650	1560
	104,475	1850
	139,300	2150

5.(b)(1) Type and Form of Materials (continued)

Notes

- Burnup = fuel element average burnup.
- Use burnup (MWd/MTU) and Enrichment Type (A, B, C, or D with limits on ^{235}U enrichment and ^{235}U mass per element) to look up minimum cooling time in days. Licensee is responsible for ensuring that uncertainties in burnup, enrichment, and mass are applied conservatively.
- Fuel with burnups greater than those listed for each Enrichment Type is not authorized for transport.
- Burnups may be either rounded up to the next higher burnup or linear interpolation may be used to determine the minimum cooling time. However, for conservatism, an additional cooling time of 30 days must be added to any linearly interpolated value.
- Example: An M-06 class element with an enrichment of 45 wt.% ^{235}U and a ^{235}U mass of 350 grams is classified as enrichment Type C. A burnup of 100,000 MWd/MTU is acceptable for transport after 1440 days cooling time as defined by 146,650 MWd/MTU from the qualification table (when linear interpolation is not employed). When linear interpolation is employed the minimum required cooling time is 1267 days (1237 days based on interpolation + 30 days additional cooling time).

(iii) Intact TRIGA fuel assemblies/elements that are enveloped by the fuel assemblies/element design characteristics listed in Table 4, intact TRIGA fuel follower control rods that are enveloped by the fuel assembly/element design characteristics listed in Table 5, with an average burnup and minimum cooling time meeting the specifications of Table 6 for fuel assemblies/elements or of Table 7 for follower control rods, and a maximum decay heat of 8 watts per assembly/element, are authorized for shipment with the TN-LC-TRIGA basket.

Intact fuel assemblies/elements are fuel assemblies/elements containing fuel rods with no known or suspected cladding defects greater than hairline cracks or pinhole leaks. The design characteristics of the TRIGA fuel assemblies/elements are described in Tables 4 and 5 below.

The fuel qualification Tables 6 and 7 specify the maximum assembly/element average burnup and minimum cooling time. The fuel elements/assemblies shall meet all the requirements of Tables 6 and 7.

The poison plates in TN-LC-TRIGA basket are constructed from either boron aluminum alloy, or metal matrix composite (MMC), or Boral®. The minimum areal density of Boron-10 (^{10}B) for either the boron enriched aluminum alloy or the metal matrix composite is 5.56 mg/cm^2. The minimum areal density of ^{10}B for Boral® is 6.67 mg/cm^2.

5.(b)(1) Type and Form of Materials (continued)

Table 4

TRIGA Fuel Assembly/Element Design Characteristics

Assembly/Element Type	Al Clad	ACPR (1)	Standard	FLIP (2)	FLIP (2) LEU-I (3)	FLIP (2) LEU-II (3)
Element ID	T-01	T-02	T-03	T-04	T-05	T-06
Fuel Material	U-ZrH	U-ZrH	U-ZrH	U-ZrH	U-ZrH	U-ZrH
Enrichment (wt.% ^{235}U)	≤ 20	≤ 20	≤ 20	≤ 70	≤ 20	≤ 20
^{235}U-Mass (g)	≤ 41	≤ 56	≤ 41	≤ 137	≤ 101	≤ 169
Active Fuel Length (inch)	≤ 15	≤ 15	≤ 15	≤ 15	≤ 15	≤ 15
Pellet Diameter (inch)	≤ 1.41	≤ 1.41	≤ 1.44	≤ 1.44	≤ 1.44	≤ 1.44
Clad Material	Al	SS304	SS304	SS304	SS304	SS304
H/Zr, max.	1.0	1.7	1.7	1.6	1.6	1.6

Table 5

TRIGA Fuel Follower Control Rods Design Characteristics

Assembly/Element Type	Standard	FLIP (2) LEU-I (3)	ACPR (1)
Element ID	T-07	T-08	T-09
Fuel Material	U-ZrH	U-ZrH	U-ZrH
Enrichment (wt. % ^{235}U)	≤ 20	≤ 20	≤ 20
^{235}U-Mass (g)	≤ 38	≤ 97	≤ 56
Active Fuel Length (inch)	≤ 15	≤ 15	≤ 15
Pellet Diameter (inch)	≤ 1.32	≤ 1.32	≤ 1.32
Clad Material	SS304	SS304	SS304
H/Zr, max.	1.7	1.6	1.7

Notes:
1. ACPR - Annular Core Pulse Reactor
2. FLIP - Fuel Life Improvement Program
3. LEU - Low Enriched Uranium

5.(b)(1) Type and Form of Materials (continued)

Table 6

TRIGA Fuel Qualification for Fuel Assembly/Elements

Element ID	Burnup (MWd/MTU)	Cooling Time (days)
T-01	35,750	400
	71,500	560
	107,250	640
	143,000	710
T-02	35,750	650
	71,500	970
	107,250	1310
	143,000	1870
T-03	35,750	520
	71,500	840
	107,250	1170
	143,000	1730
T-04	112,500	1000
	225,000	1380
	337,500	1820
	450,000	2520
T-05	35,750	920
	71,500	1290
	107,250	1710
	143,000	2360
T-06	36,500	1190
	73,000	1690
	109,500	2320
	146,000	3170

5.(b)(1) Type and Form of Materials (continued)

Table 7

TRIGA Fuel Qualification for Fuel Follower Control Rods

Element ID	Burnup (MWd/MTU)	Cooling Time (days)
T-07	35,750	540
	71,500	890
	107,250	1280
	143,000	1960
T-08	35,750	940
	71,500	1350
	107,250	1840
	143,000	2580
T-09	35,750	670
	71,500	1020
	107,250	1420
	143,000	2100

Notes for Tables 6 and 7:

- Burnup = fuel element / assembly / follower control rod average burnup.
- Use burnup (MWd/MTU) and Element ID to look-up minimum cooling time in days. Licensee is responsible for ensuring that uncertainties in burnup are applied conservatively.
- Fuel with a burnup greater than that listed for each element type in Tables 6 and 7 is unacceptable for transport.
- Burnups may be either rounded up to the next higher burnup or linear interpolation may be used to determine the minimum cooling time. However, for conservatism, an additional cooling time of 30 days must be added to any linearly interpolated value.
- Example: A T-03 element with a burnup of 100,000 MWd/MTU is acceptable for transport after 1170 days cooling time as defined by 107,250 MWd/MTU (Table 6, rounding up) on the qualification table (when linear interpolation is not employed). When linear interpolation is employed the minimum required cooling time is 1133 days (1103 days based on interpolation + 30 days additional cooling time).

(iv) Intact PWR fuel assembly, as specified in Table 8, or intact BWR fuel assembly, as specified in Table 13, or fuel rods in a pin can are authorized for transport with the TN-LC-1FA basket.

Intact fuel assemblies are fuel assemblies containing fuel rods with no known or suspected cladding defects greater than hairline cracks or pinhole leaks.

5.(b)(1) Type and Form of Materials (continued)

The fuel rods include irradiated PWR, BWR, MOX, and EPR fuel rods. PWR intact and BWR intact fuel rods may be from any of the fuel assemblies listed in Table 8 or Table 13, respectively.

MOX rods have the same geometry as PWR or BWR rods, as defined in Table 8 and Table 13. The composition of MOX fuel is specified in Table 12.

The EPR fuel rods are specified in Table 10.

The poison plates in the TN-LC-1FA basket are constructed from boron aluminum alloy, or metal matrix composite (MMC), or Boral®. The minimum ^{10}B aeral density of the poison plate is 16.7 mg/cm^2 for either the boron aluminum alloy or the MMC. The minimum ^{10}B aeral density of the poison plate is 20.0 mg/cm^2 for Boral®.

In addition to the poison plates provided in the basket, Poison Rod Assemblies (PRAs) are required for transportation of PWR fuel assemblies. The minimum required B_4C content of the absorber rods in the PRA is 40% Theoretical Density (TD). A summary of the number of absorber rods required in the PRA for each PWR fuel class is shown in Table 11. PRA loading configurations are also illustrated in Figure 1 through Figure 4.

The PWR fuel assemblies fuel qualification table (FQT) is provided in Table 15.

The BWR fuel assemblies FQT is provided in Table 16.

The PWR rod FQTs are shown in Table 17 and Table 18 for the 25 and 9 rod configurations, respectively.

The BWR rod FQTs are shown in Table 19 and Table 20 for the 25 and 9 rod configurations, respectively.

The MOX rod FQT, provided in Table 21 for both 25 and 9 rods, is applicable to both BWR and PWR MOX rods.

The FQTs for the UO_2 Standard EPR rods are governed by the PWR rod FQTs (Table 17 and Table 18), while the FQT for the MOX EPR rods is governed by the MOX rod FQT (Table 21).

5.(b)(1) Type and Form of Materials (continued)

Table 8
PWR Fuel Specifications for Transport in the TN-LC-1FA Basket

Fuel Class (1) (2)	One intact unconsolidated B&W 17x17, WE 17x17, CE 16x16, B&W 15x15, WE 15x15, CE 15x15, WE 14x14, or CE 14x14 class PWR assembly (without control components) that are enveloped by the fuel assembly design characteristics listed in Table 9. Reload fuel manufactured by the same or other vendors, but enveloped by the design characteristics listed in Table 9, is also acceptable.
Maximum Assembly + PRA Weight	1850 lbs
Fissile Material	UO_2
Maximum Initial Uranium Content(4)	490 kg/assembly
Maximum Unirradiated Assembly Length	178.3 inches
Fuel Assembly Average Burnup, Enrichment and Minimum Cooling Time	Per Table 15
Maximum Planar Initial Enrichment	5.0(3) wt.% ^{235}U
Maximum Decay Heat(5)	3.0 kW per Assembly
Minimum ^{10}B areal density in poison plates	• 16.7 mg/cm^2 (Natural or Enriched Boron Aluminum Alloy / Metal Matrix Composite (MMC)) • 20.0 mg/cm^2 (Boral®)
Minimum number of absorber rods per PRA as a function of assembly class	Per Table 11

Notes:
1. Up to 25 PWR fuel rods from any of the PWR fuel assemblies listed in Table 9 may also be transported in the TN-LC-1FA basket in a 25 pin can. The fuel rods are loaded in a 25 pin can with a cavity length of 168.5 inches (Option 3) which is placed within the TN-LC-1FA basket. The maximum peak burnup for the fuel rods is 90 GWd/MTU. The required cooling time, as a function of a PWR fuel rod burnup and enrichment, is provided in Table 17 for 25 rods and Table 18 for 9 rods, respectively.
2. Up to 25 EPR fuel rods from any of the fuel class listed in Table 9 and meeting EPR rod parameters specified in Table 10 may also be loaded in the TN-LC-1FA basket. The fuel rods are loaded in a 25 pin can with a cavity length of 179.5 inches (Option 1 and Option 2) which is placed within the TN-LC-1FA basket. The maximum peak burnup for the fuel rods is 90 GWd/MTU. The required cooling time, as a function of an EPR fuel rod burnup and enrichment, is provided in Table 17 for 25 rods and Table 18 for 9 rods, respectively.
3. For CE 15x15, the maximum planar average initial enrichment is 3.70 wt.% ^{235}U.
4. The maximum initial uranium content is based on the shielding analysis. The listed value is higher than the actual.
5. The maximum decay heat per rod is 220 watts when loading up to 9 rods. The maximum decay heat per rod is 120 watts when loading 10 or more (up to 25) rods.

5.(b)(1) Type and Form of Materials (continued)

Table 9
PWR Fuel Assembly Design Characteristics for Transportation in the TN-LC-1FA Basket

Assembly Class	B&W 15x15	B&W 17x17	WE 17x17	CE 15x15	WE 15x15	CE 14x14	WE 14x14	CE 16x16
Maximum Number of Fuel Rods	208	264	264	216	204	176	179	236
Maximum Number of Guide/Instrument Tubes	17	25	25	9	21	5	17	5
Rod Pitch(1) (inch)	≤ 0.568	≤ 0.502	≤ 0.496	≤ 0.550	≤ 0.563	≤ 0.580	≤ 0.556	≤ 0.506
Pellet Diameter(1) (inch)	≤ 0.374	≤ 0.323	≤ 0.323	≤ 0.360	≤ 0.367	≤ 0.382	≤ 0.368	≤ 0.326
Clad Outer Diameter(1) (inch)	≥ 0.416	≥ 0.379	≥ 0.360	≥ 0.417	≥ 0.422	≥ 0.440	≥ 0.400	≥ 0.382
Clad Thickness(1) (inch)	≥ 0.024	≥ 0.024	≥ 0.022	≥ 0.026	≥ 0.024	≥ 0.026	≥ 0.022	≥ 0.023

Note 1. The fuel assembly fabrication documentation may be used to demonstrate compliance with these fuel assembly parameters. The fuel assembly parameters are design nominal values. The maximum and minimum dimensions are specified to bound variations in design nominal values among fuel assemblies within a fuel assembly class (or an array type).

Table 10
Irradiated EPR Fuel Rod Parameters

Parameter	Value
Maximum Unirradiated Length	179.5 inches
Cladding Thickness	Nominal 0.022 inch
Maximum Initial Uranium Content	2.05 kgU/rod

Table 11
Summary of PRA Requirements for PWR Fuel Assembly Classes

Assembly Class	Number of Absorber Rods in PRAs and Locations	Diameter of B_4C Absorber (cm)	Minimum B_4C Content (g/cm)
WE 17x17	8, Per Figure 4	0.88	0.613
CE 16x16	5, All Guide Tubes	1.02	0.824
BW 15x15	8, Per Figure 3	0.88	0.613
CE 15x15	1, Center Guide Tube	0.76	0.475
WE 15x15	8, Per Figure 2	0.88	0.613
CE 14x14	5, All Guide Tubes	1.02	0.824
WE 14x14	8, Per Figure 1	0.88	0.613
BW 17x17	8, Per Figure 4	0.76	0.475

5.(b)(1) Type and Form of Materials (continued)

Table 12
MOX Fuel Rods Specifications for Transport in the TN-LC-1FA Basket

PHYSICAL PARAMETERS:	• Up to 25 PWR MOX fuel rods with physical parameters as those listed in Table 8. • Up to 25 BWR MOX fuel rods with physical parameters as those listed in Table 13. • Up to 25 EPR MOX fuel rods with physical parameters as those listed in Table 10.
Fissile Material	UO_2, PuO_2 (Mixed Oxide or MOX)
Heavy Metal (HM) Content	≤ 2.5 kgU/rod
CRITICALITY PARAMETERS: Initial MOX composition	• ^{235}U Content in UO_2 : $0.5 \leq {}^{235}U \leq 0.7$ wt.% • Plutonium Content: Pu / (U + Pu) ≤ 7.0 wt.% • Initial ^{239}Pu Content in PuO_2 ≤ 60.0 wt.% • Initial ^{241}Pu Content in PuO_2 ≤ 7.5 wt.%
THERMAL/RADIOLOGICAL PARAMETERS: Initial MOX Composition for Fuel Qualification Burnup and Minimum cooling time for MOX rods	• ^{238}Pu / ^{239}Pu ≤ 4.0 wt.% • ^{239}Pu/ PuO_2 ≥ 50 wt.% • ^{241}Am / PuO_2 ≤ 70 ppm • $^{235}U/U$ ≤ 0.5 wt.% Per Table 21.
Maximum Decay heat per 25 pin can	• 3.0 kW for the 25 pin can with up to 25 rods • 1.98 kW for the 25 pin can with up to 9 rods
Minimum ^{10}B aeral density in poison plates	• 16.7 mg/cm^2 Boron Aluminum Alloy / Metal Matrix Composite (MMC) • 20.0 mg/cm^2 (Boral®)

5.(b)(1) Type and Form of Materials (continued)

Table 13
BWR Fuel Specification for Transport in the TN-LC-1FA Basket

PHYSICAL PARAMETERS: Fuel Class[(1)]	One intact 7x7, 8x8, 9x9, or 10x10 BWR assembly manufactured by General Electric or Exxon/ANF or FANP or ABB or reload fuel manufactured by same or other vendors that are enveloped by the fuel assembly design characteristics listed in Table 14.
Channels	Fuel may be transported with or without channels, channel fasteners, or finger springs.
Fissile Material	UO_2
Maximum Assembly Weight with Channels	790 lbs
Maximum Unirradiated Assembly Length	176.6 inches
THERMAL/RADIOLOGICAL PARAMETERS: Maximum Planar Average Initial Enrichment	5.0 wt.% ^{235}U
Fuel Assembly Average Burnup, Enrichment and Minimum Cooling Time	Per Table 16.
Maximum Decay Heat[(2)]	2.0 kW per Assembly
Minimum ^{10}B aeral density in poison plates	• 16.7 mg/cm^2 Boron Aluminum Alloy / Metal Matrix Composite (MMC) • 20.0 mg/cm^2 (Boral®)

Notes:

1. Up to 25 fuel rods from any of the BWR fuel assemblies listed in Table 14 may also be transported in the TN-LC-1FA basket in the 25 pin can. The fuel rods are loaded in a 25 pin can with a cavity length of 168.5 inches which is placed within the TN-LC-1FA basket. The required cooling time as a function of BWR fuel rod burnup and enrichment are provided in Table 19 for 25 rods and Table 20 for 9 rods, respectively.
2. The maximum decay heat per rod is 220 watts when loading up to 9 rods. The maximum decay heat per rod is 120 watts when loading 10 or more (up to 25) rods.

5.(b)(1) Type and Form of Materials (continued)

Table 14
BWR Fuel Assembly Design Characteristics(1) for Transportation in the TN-LC-1FA Basket
(Part 1 of 3)

Transnuclear ID	7x7-49/0	8x8-63/1	8x8-62/2	8x8-60/4	8x8-60/1	9x9-74/2
Initial Design or Reload Fuel Designation	GE1	GE4	GE-5	GE8 Type II	GE9	GE11
	GE2		GE-Pres		GE10	GE13
	GE3		GE-Barrier			
			GE8 Type I			
			FANP 8x8-2			
Maximum Number of Fuel Rods	49	63	62	60	60	74
Maximum Initial Uranium Content (kg)	198	192	192	192	192	192
Rod Pitch(5) (inch)	≤ 0.738	≤ 0.640	≤ 0.640	≤ 0.640	≤ 0.640	≤ 0.566
Pellet Diameter(5) (inch)	≤ 0.487	≤ 0.416	≤ 0.411	≤ 0.411	≤ 0.411	≤ 0.376
Clad Outer Diameter(5) (inch)	≥ 0.563	≥ 0.493	≥ 0.483	≥ 0.483	≥ 0.483	≥ 0.440
Clad Thickness(5) (inch)	≥ 0.032	≥ 0.034	≥ 0.032	≥ 0.032	≥ 0.032	≥ 0.028

Table 14
BWR Fuel Assembly Design Characteristics(1) for Transportation in the TN-LC-1FA Basket
(Part 2 of 3)

Transnuclear ID	10x10-92/2	7x7-49/0Z	7x7-48/1Z	8x8-60/4Z	FANP 9x9	Siemens QFA
Initial Design or Reload Fuel Designation	GE12	ENC-IIIA	ENC-III(2)	ENC Va	FANP9 9x9(3)	9x9
	GE14			ENC Vb		
Maximum Number of Fuel Rods	92	49	48	60	81	72
Maximum Initial Uranium Content (kg)	192	198	198	192	192	192
Rod Pitch(5) (inch)	≤ 0.510	≤ 0.738	≤ 0.738	≤ 0.642	≤ 0.572	≤ 0.570
Pellet Diameter(5) (inch)	≤ 0.345	≤ 0.488	≤ 0.491	≤ 0.420	≤ 0.357	≤ 0.374
Clad Outer Diameter(5) (inch)	≥ 0.404	≥ 0.570	≥ 0.570	≥ 0.501	≥ 0.424	≥ 0.433
Clad Thickness(5) (inch)	≥ 0.026	≥ 0.035	≥ 0.035	≥ 0.036	≥ 0.030	≥ 0.026

5.(b)(1) Type and Form of Materials (continued)

Table 14
BWR Fuel Assembly Design Characteristics[1] for Transportation in the TN-LC-1FA Basket
(Part 3 of 3)

Transnuclear ID	10x10-91/1	ABB-8x8	ABB-10x10	LaCrosse
Initial Design or Reload Fuel Designation	ATRIUM 10	SVEA-64	SVEA-100[4]	Allis Chalmers - 10x10
	ATRIUM 10XM			Exxon/ANF 10x10
Maximum Number of Fuel Rods	91	64	100	100
Maximum Initial Uranium Content (kg)	192	192	192	125
Rod Pitch[5] (inch)	≤ 0.510	≤ 0.622	≤ 0.512	≤ 0.565
Pellet Diameter[5] (inch)	≤ 0.350	≤ 0.411	≤ 0.346	≤ 0.350
Clad Outer Diameter[5] (inch)	≥ 0.405	≥ 0.378	≥ 0.378	≥ 0.394
Clad Thickness[5] (inch)	≥ 0.023	≥ 0.024	≥ 0.022	≥ 0.020

Notes:

1. Any fuel channel average thickness up to 0.120 inch is acceptable on any of the fuel designs.
2. Includes ENC-IIIE and ENC-IIIF.
3. Includes FANP 9x9-72, 9x9-79, 9x9-80, and 9x9-81.
4. Includes SVEA-92, SVEA-96, SVEA-96+, SVEA-96 OPTIMA, SVEA-96 OPTIMA2, SVEA-96+/L.
5. The fuel assembly fabrication documentation may be used to demonstrate compliance with these fuel assembly parameters. The fuel assembly parameters are design nominal values. The maximum and minimum dimensions are specified to bound variations in design nominal values among fuel assemblies within a fuel assembly class (or an array type).

(2) Maximum quantity of material per package

(i) For the contents described in Item 5(b)(1)(i): 26 intact or damaged either NRU or NRX Mk I fuel assemblies, with an approximate maximum payload of 331 lb.

(ii) For the contents described in Item 5(b)(1)(ii): 54 intact or damaged MTR fuel elements, with an approximate maximum payload of 1,620 lb.

(iii) For the contents described in Item 5(b)(1)(iii): 180 intact TRIGA fuel elements/assemblies with an approximate maximum payload of 2,380 lb.

5.(b)(2) Maximum quantity of material per package (continued)

(iv) For the contents described in Item 5(b)(1)(iv): one intact PWR fuel assembly, or one intact BWR fuel assembly, or up to 25 intact PWR (including MOX and EPR) or BWR fuel rods in a pin can. When transporting 9 or fewer fuel rods, the rods shall be placed in the center 3x3 region of the pin can. The approximate maximum payload is 1,650 lb per PWR assembly, 1,850 lb per BWR assembly with PRAs, 710 lb per PWR assembly, 790 lb per BWR assembly with channels, and 16 lb per fuel rod.

(3) The maximum decay heat for any payload is 3.0 kW.

5(c) Criticality Safety Index (CSI):

For NRU and NRX fuel assemblies described in 5(b)(1)(i) and limited in 5(b)(2)(i)	100
For MTR fuel elements described in 5(b)(1)(ii) and limited in 5(b)(2)(ii)	100
For TRIGA fuel assemblies/elements described in 5(b)(1)(iii) and limited in 5(b)(2)(iii)	0
For intact BWR fuel assemblies described in 5(b)(1)(iv) and limited in 5(b)(2)(iv)	0
For intact PWR fuel assemblies described in 5(b)(1)(iv) and limited in 5(b)(2)(iv)	100
For fuel rods in a 25 pin can described in 5(b)(1)(iv) and limited in 5(b)(2)(iv)	0

Table 15
Fuel Qualification Table for a PWR Fuel Assembly

(Minimum required years of cooling time after reactor core discharge)

Burnup, GWd/ MTU	Enrichment (wt. % ^{235}U)															
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
10	2.25	2.25	2.20	2.10	2.05	2.05	2.05	2.00	2.00	2.00	2.00	2.00	2.00	1.95	1.95	1.95
20	3.37	3.35	3.30	3.20	3.05	2.90	2.90	2.85	2.85	2.80	2.80	2.80	2.75	2.75	2.75	2.75
30			4.70	4.35	4.10	3.80	3.70	3.65	3.60	3.60	3.55	3.50	3.45	3.45	3.40	3.35
39						4.95	4.85	4.75	4.65	4.55	4.45	4.40	4.35	4.25	4.20	4.15
40												4.55	4.45	4.35	4.30	4.25
45												5.40	5.25	5.15	5.05	4.95
50												6.80	6.60	6.50	6.25	6.15
55												8.85	8.60	8.30	8.05	7.85
60												11.55	11.20	10.85	10.50	10.15
61												12.15	11.80	11.45	11.10	10.70
62												12.80	12.40	12.05	11.65	11.30
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0

Burnup, GWd/ MTU	Enrichment (wt. % ^{235}U)																			
	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0
10	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90
20	2.75	2.75	2.70	2.70	2.70	2.70	2.65	2.65	2.65	2.65	2.65	2.65	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.55
30	3.35	3.35	3.30	3.30	3.25	3.25	3.20	3.20	3.15	3.15	3.15	3.15	3.15	3.15	3.10	3.10	3.10	3.05	3.05	3.05
39	4.10	4.00	3.95	3.95	3.90	3.85	3.80	3.75	3.70	3.70	3.70	3.65	3.65	3.60	3.55	3.55	3.50	3.50	3.50	3.50
40	4.15	4.15	4.10	4.05	4.00	3.90	3.90	3.90	3.85	3.80	3.75	3.70	3.70	3.65	3.65	3.65	3.60	3.55	3.55	3.50
45	4.85	4.80	4.70	4.60	4.55	4.50	4.45	4.35	4.35	4.30	4.20	4.15	4.10	4.10	4.05	4.00	3.95	3.95	3.90	3.85
50	6.00	5.85	5.75	5.60	5.50	5.40	5.30	5.20	5.10	5.05	4.95	4.90	4.85	4.75	4.70	4.65	4.55	4.55	4.50	4.40
55	7.65	7.35	7.15	7.00	6.80	6.65	6.45	6.30	6.20	6.05	5.90	5.85	5.70	5.65	5.50	5.45	5.35	5.30	5.25	5.15
60	9.80	9.55	9.20	8.95	8.70	8.45	8.25	8.00	7.80	7.55	7.40	7.20	7.05	6.85	6.75	6.60	6.45	6.35	6.25	6.10
61	10.35	10.10	9.75	9.45	9.20	8.90	8.65	8.35	8.20	7.90	7.75	7.55	7.40	7.20	7.00	6.85	6.75	6.55	6.50	6.40
62	10.90	10.65	10.25	9.95	9.70	9.40	9.10	8.85	8.55	8.35	8.15	7.90	7.70	7.50	7.30	7.20	7.05	6.85	6.75	6.65
	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0

Notes:

1. Explanatory notes and limitations regarding the use of this table follow Table 21.

Table 16
Fuel Qualification Table for a BWR Fuel Assembly

(Minimum required years of cooling time after reactor core discharge)

Burnup, GWd/ MTU	Enrichment (wt. % ^{235}U)																																			
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0
10	0.65	0.65	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
20	0.95	0.95	0.90	0.85	0.80	0.80	0.80	0.80	0.80	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
30			1.25	1.20	1.15	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.95	0.95	0.95
39						1.40	1.40	1.40	1.35	1.35	1.35	1.35	1.30	1.30	1.30	1.30	1.30	1.25	1.25	1.25	1.25	1.25	1.20	1.20	1.20	1.20	1.20	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
40												1.40	1.40	1.35	1.35	1.35	1.35	1.30	1.30	1.30	1.30	1.30	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.20	1.20	1.20	1.20	1.20	1.20	1.20
45												1.60	1.60	1.60	1.55	1.55	1.55	1.55	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.45	1.45	1.45	1.45	1.45	1.45	1.40	1.40	1.40
50												1.85	1.85	1.85	1.80	1.80	1.80	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.70	1.70	1.70	1.70	1.65	1.65	1.65	1.65	1.65	1.60	1.60
55												2.10	2.10	2.10	2.05	2.05	2.05	2.00	2.00	2.00	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.90	1.90	1.90	1.90	1.90	1.85	1.85	1.85	1.85
60												2.35	2.35	2.35	2.30	2.30	2.30	2.25	2.25	2.25	2.20	2.20	2.20	2.20	2.20	2.20	2.15	2.15	2.15	2.15	2.10	2.10	2.10	2.10	2.05	2.05
61												2.40	2.40	2.40	2.35	2.35	2.35	2.30	2.30	2.30	2.25	2.25	2.25	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.15	2.15	2.15	2.15	2.10	2.10
62												2.45	2.45	2.45	2.40	2.40	2.40	2.35	2.35	2.35	2.30	2.30	2.30	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.20	2.20	2.20	2.20	2.15	2.15
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0

Notes:

1. Explanatory notes and limitations regarding the use of this table follow Table 21.

Table 17
Fuel Qualification Table for 25 PWR/EPR Fuel Rods (UO_2)

(Minimum required years of cooling time after reactor core discharge)

Burnup, GWd/ MTU	Enrichment (wt. % ^{235}U)																																		
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0
10	0.30	0.30	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
20	0.30	0.30	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
30			0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
39						0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
40												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
45												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
50												0.30	0.30	0.30	0.30	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
55												0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
60												0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
61												0.40	0.40	0.40	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.30	0.30
62												0.40	0.40	0.40	0.40	0.40	0.40	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
65																							0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.35	0.35	0.35	0.35	0.35	0.35
70																							0.50	0.50	0.50	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
75																							0.65	0.65	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.50	0.50	0.50	0.50
80																							0.85	0.85	0.75	0.75	0.75	0.75	0.75	0.70	0.70	0.70	0.70	0.70	0.70	0.70
85																							1.05	1.00	1.00	1.00	0.90	0.90	0.90	0.90	0.85	0.85	0.85	0.85	0.85	0.85
90																							1.25	1.25	1.25	1.15	1.15	1.15	1.10	1.10	1.10	1.00	1.00	1.00	1.00	0.95
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0

Notes:

1. Explanatory notes and limitations regarding the use of this table follow Table 21.

Table 18
Fuel Qualification Table for 9 PWR/EPR Fuel Rods (UO_2)

(Minimum required years of cooling time after reactor core discharge)

Burnup, GWd/MTU	Enrichment (wt. % ^{235}U)																																		
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0
10	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
20	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
30			0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
39						0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
40												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
45												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
50												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
55												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
60												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
61												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
62												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
65																							0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
70																							0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
75																							0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
80																							0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
85																							0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
90																							0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0

Notes:

1. Explanatory notes and limitations regarding the use of this table follow Table 21.

Table 19
Fuel Qualification Table for 25 BWR Fuel Rods (UO_2)

(Minimum required years of cooling time after reactor core discharge)

Burnup, GWd/ MTU	Enrichment (wt. % ^{235}U)																					
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6
10	0.30	0.30	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
20	0.30	0.30	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
30			0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
39						0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
40												0.40	0.40	0.40	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
45												0.45	0.45	0.45	0.45	0.40	0.40	0.40	0.40	0.40	0.40	0.40
50												0.60	0.60	0.60	0.60	0.55	0.55	0.55	0.55	0.55	0.55	0.55
55												0.75	0.75	0.75	0.75	0.75	0.70	0.70	0.70	0.70	0.70	0.70
60												1.00	1.00	1.00	1.00	0.90	0.90	0.90	0.90	0.90	0.85	0.85
61												1.05	1.05	1.00	1.00	1.00	1.00	1.00	0.90	0.90	0.90	0.90
62												1.10	1.05	1.05	1.05	1.05	1.00	1.00	1.00	1.00	1.00	0.90
65																						
70																						
75																						
80																						
85																						
90																						
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6

Burnup, GWd/ MTU	Enrichment (wt. % ^{235}U)													
	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0
10	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
20	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
39	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
40	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
45	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
50	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.50	0.50	0.50	0.50	0.50	0.50	0.50
55	0.70	0.70	0.70	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
60	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
61	0.90	0.90	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.75	0.75
62	0.90	0.90	0.90	0.90	0.90	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
65	1.05	1.05	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.90	0.90	0.90	0.90
70	1.20	1.20	1.20	1.15	1.15	1.15	1.15	1.15	1.15	1.10	1.10	1.10	1.10	1.10
75	1.45	1.45	1.45	1.40	1.40	1.40	1.30	1.30	1.30	1.30	1.25	1.25	1.25	1.25
80	1.70	1.70	1.65	1.65	1.60	1.60	1.60	1.50	1.50	1.50	1.45	1.45	1.45	1.45
85	2.15	2.05	2.00	2.00	1.95	1.85	1.85	1.80	1.80	1.70	1.70	1.65	1.65	1.65
90	2.60	2.55	2.50	2.40	2.35	2.30	2.20	2.15	2.15	2.10	2.00	2.00	1.95	1.95
	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0

Notes:

1. Explanatory notes and limitations regarding the use of this table follow Table 21.

Table 20
Fuel Qualification Table for 9 BWR Fuel Rods (UO_2)

(Minimum required years of cooling time after reactor core discharge)

Burnup, GWd/ MTU	Enrichment (wt. % ^{235}U)																																		
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0
10	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
20	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
30			0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
39						0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
40												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
45												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
50												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
55												0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
60												0.30	0.30	0.30	0.30	0.30	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
61												0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.25	0.25	0.25
62												0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
65																							0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
70																							0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
75																							0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
80																							0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
85																							0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
90																							0.60	0.60	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
	0.7	0.8	0.9	1.2	1.5	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0

Notes:

1. Explanatory notes and limitations regarding the use of this table follow Table 21.

Table 21

Fuel Qualification Table for MOX PWR/BWR 25 Rods and MOX PWR/BWR/EPR 9 Rods

Burnup, GWd/MTHM	9 Rods		25 Rods	
	0.5 wt.% of ^{235}U	0.7 wt.% of ^{235}U	0.5 wt.% of ^{235}U	0.7 wt.% of ^{235}U
10	0.25	0.25	0.25	0.25
20	0.25	0.25	0.30	0.30
30	0.25	0.25	0.50	0.50
40	0.25	0.25	0.95	0.95
45	0.25	0.25	1.25	1.25
50	0.35	0.35	1.70	1.70
55	0.40	0.40	2.20	2.10
60	0.45	0.45	2.80	2.70
62	0.55	0.55	3.75	3.65

Notes:

1. Explanatory notes and limitation regarding the use of this table are provided on the following page.

Notes:

General

1. Use burnup and enrichment to look up minimum cooling time in years. Licensee is responsible for ensuring that uncertainties in fuel enrichment and burnup are correctly accounted for during fuel qualification.
2. For values not explicitly listed in the tables, round burnups **up** to the first value shown, round enrichments **down**, and select the cooling time listed.
3. UO_2 Fuel with an initial enrichment less than 0.7 (or less than the minimum provided above for each burnup) or greater than 5.0 wt.% ^{235}U is unacceptable for transportation.
4. Shaded areas in these Tables indicate fuel is not analyzed for loading.

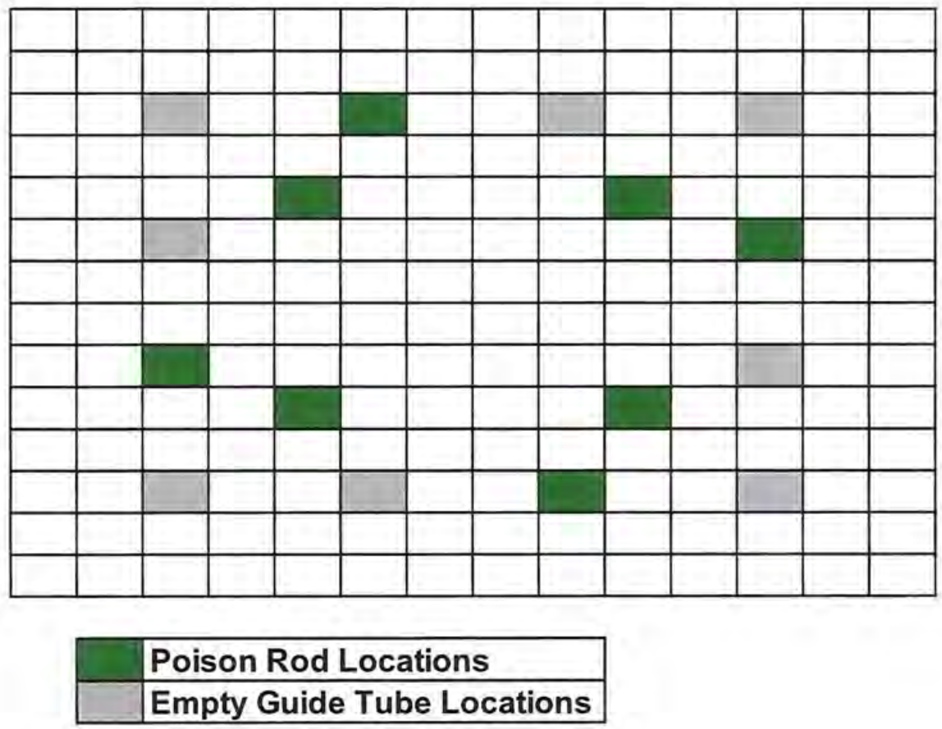
For Fuel Assemblies

1. Burnup = Assembly Average burnup.
2. Enrichment = Assembly Average Enrichment.
3. Fuel assembly with a burnup greater than 62 GWd/MTU is unacceptable for transportation.

For Fuel Rods

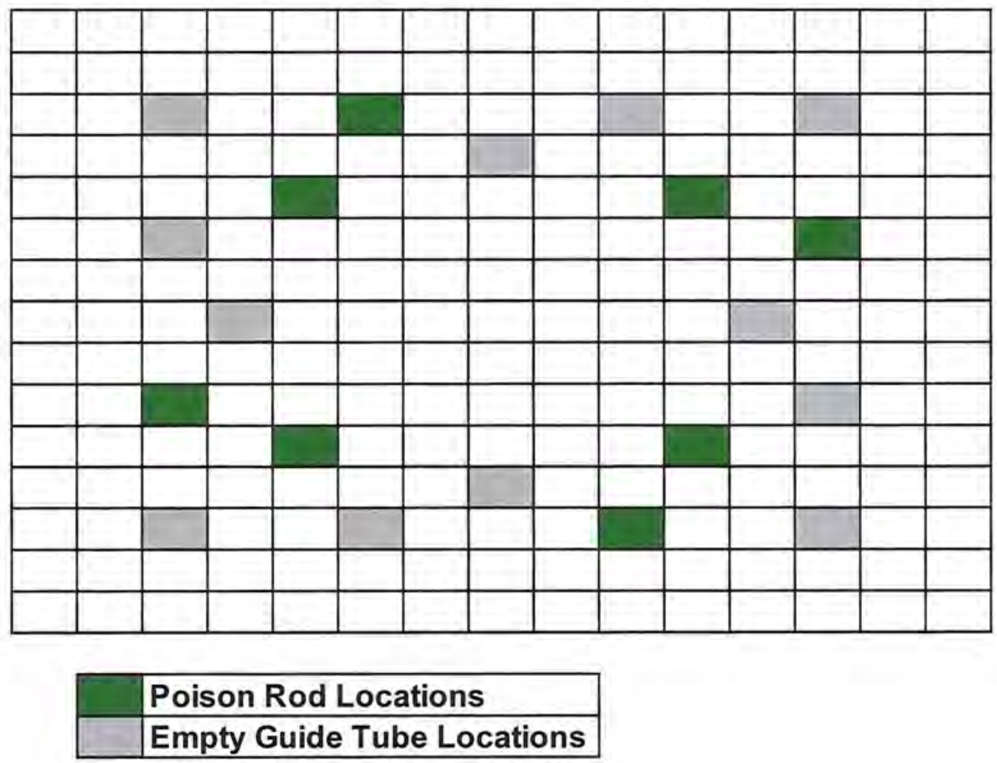
4. Burnup = Maximum burnup.
5. Enrichment = Rod Average Enrichment.
6. When transporting 25 or less fuel rods, the rods shall be placed in a specially designed 25 pin can.
7. When transporting 9 or less fuel rods, the rods shall be placed in the 3x3 region of the 25 pin can.
8. Fuel rods with a burnup greater than 90 GWd/MTU are unacceptable for transportation.

Example: Per Table 15, a PWR assembly with an initial enrichment of 4.85 wt.% ^{235}U and a burnup of 41.5 GWd/MTU is acceptable for transport after a 3.95-year cooling time as defined by 4.8 wt.% ^{235}U (rounding down) and 45 GWd/MTU (rounding up) on the qualification table (other considerations not withstanding).



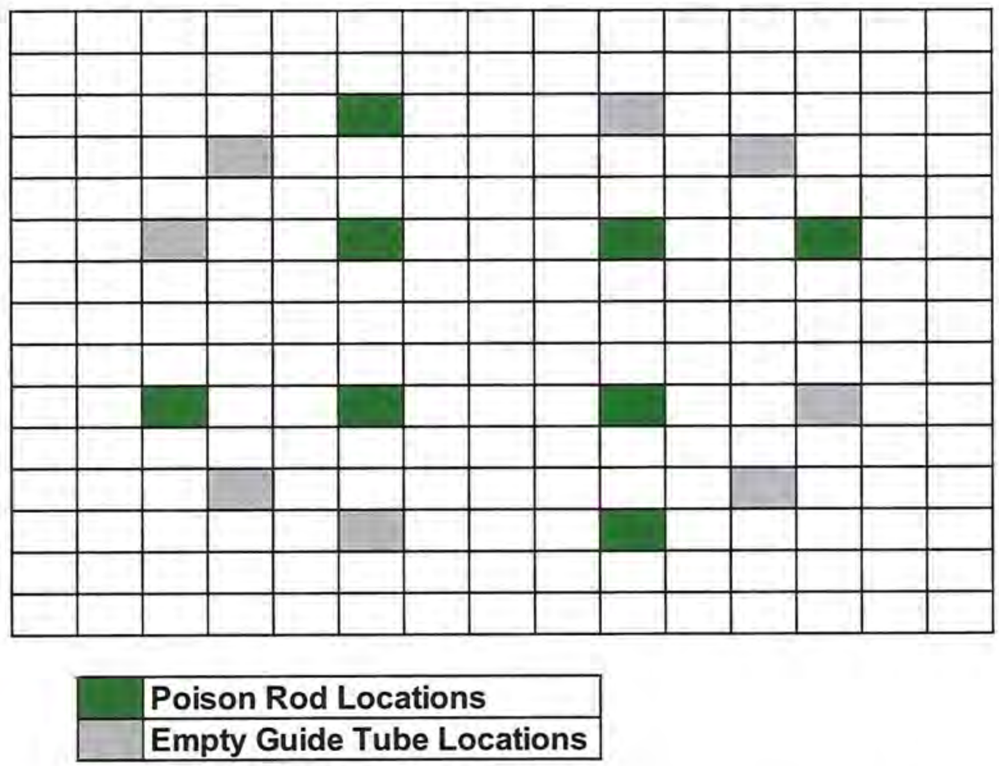
Note: This configuration indicates the relative location of the poison rods within the guide tubes and does not provide any other fuel class specific information. Any other configuration of poison rods that is rotationally symmetric is also acceptable.

Figure 1
PRA Insertion Locations for WE 14x14 Class Assemblies



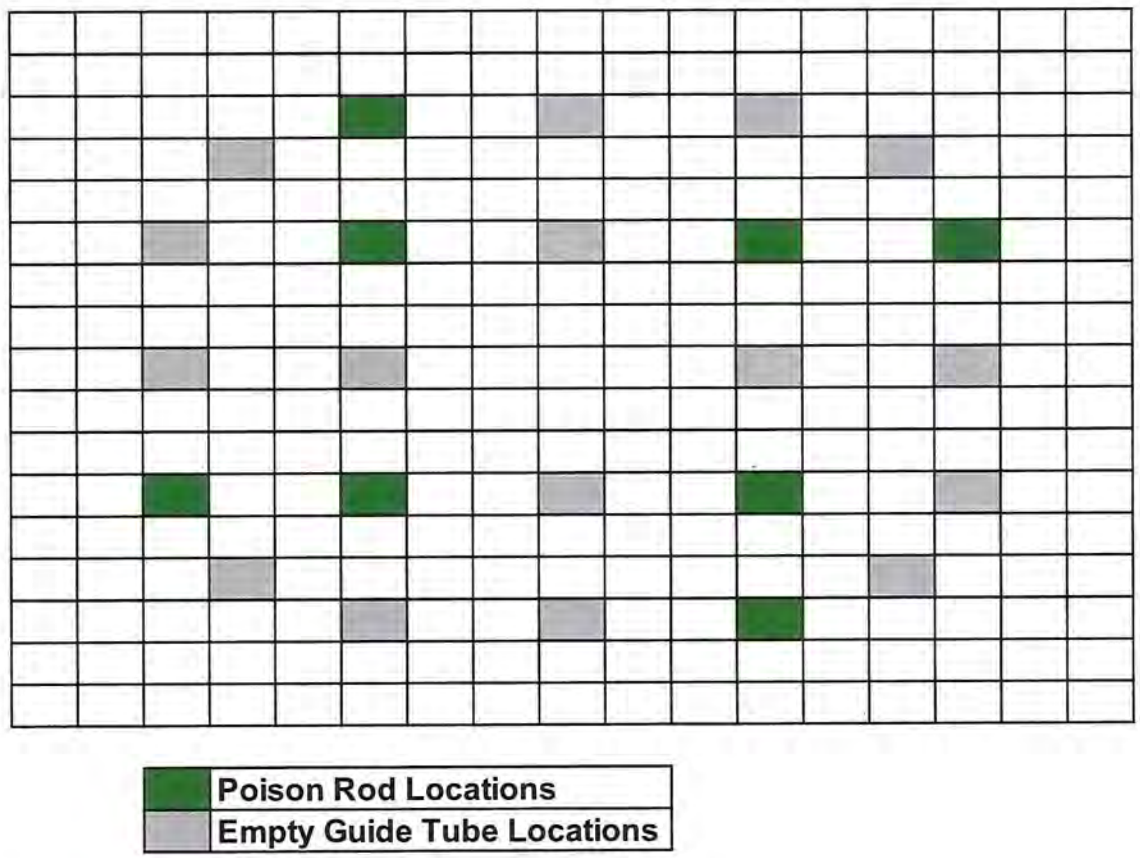
Note: This configuration indicates the relative location of the poison rods within the guide tubes and does not provide any other fuel class specific information. Any other configuration of poison rods that is rotationally symmetric is also acceptable.

Figure 2
PRA Insertion Locations for WE 15x15 Class Assemblies



Note: This configuration indicates the relative location of the poison rods within the guide tubes and does not provide any other fuel class specific information. Any other configuration of poison rods that is rotationally symmetric is also acceptable.

Figure 3
PRA Insertion Locations for BW 15x15 Class Assemblies



Note: This configuration indicates the relative location of the poison rods within the guide tubes and does not provide any other fuel class specific information. Any other configuration of poison rods that is rotationally symmetric is also acceptable.

Figure 4
PRA Insertion Locations for BW 17x17 and WE 17x17 Class Assemblies

6. In addition to the requirements of Subpart G of 10 CFR Part 71:

   (a) The package must be prepared for shipment and operated in accordance with the Operating Procedures of Chapter No. 7 of the application, and

   (b) Each packaging must meet the Acceptance Tests and Maintenance Program of Chapter No. 8 of the application.

7. Transport by air of fissile material is not authorized.

8. Prior to the first shipment, the package shall be tested for the entire containment boundary, e.g., all base metal, all joining containment welds, vent port plug seal, drain port plug seal, lid seal, and bottom plug seal, in accordance with ANSI N14.5, by helium leakage rate testing to meet the leaktight criteria of $1.0\text{x}10^{-7}$ ref-cm^3/sec for fabrication leakage tests.

9. Poison Rod Assemblies, required for shipment of PWR assemblies, shall be installed such that the active fuel length is covered by the absorber, and measures shall be taken against their inadvertent removal from the fuel assembly.

10. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR 71.17.

11. Revision No. 1 of this certificate may be used until April 30, 2015.

12. Expiration date: December 31, 2017.

REFERENCES

Transnuclear, Inc., TN-LC Transportation Package Safety Analysis Report, Revision No. 6, dated November 2012.

Supplements dated November 27 and December 18, 2012; January 27, 2014; October 11, 2013, December 13, 2013 and March 24, 2014.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Michele Sampson, Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Date: April 29, 2014

U.S. Department
of Transportation

East Building, PHH-23
1200 New Jersey Avenue SE
Washington, D.C. 20590

**Pipeline and
Hazardous Materials
Safety Administration**

CERTIFICATE NUMBER: USA/9358/B(U)F-96, Revision 1

ORIGINAL REGISTRANT(S):

Mr. Jim Davis
Areva - TN Inc
2101 Horn Rapids Road
Richland, WA 99352

Ralf Witten
Areva - TN Inc
Abteilung ANF-LP
Advanced Nuclear Fuels GmbH
Postfach 1485
Lingen, Niedersachsen 49784
Germany

Mr. Robert Link
Areva - TN Inc
2101 Horn Rapids Road
Richland, 99352
USA

Glenn Mathues
Licensing Engineer (Transportation)
Areva - TN Inc
7135 Minstrel Way
Suite 300
Columbia, MD 21045

Mike Valenzano
Director of Transport Operations
Areva - TN Inc
7135 Minstrel Way
Suite 300
Columbia, MD 21045